Minia J. of Agric. Res. & Develop.
Vol. (34), No. 3, pp. 385-402, 2014

FACULTY OF AGRICULTURE

EFFECTS OF FENUGREEK SEED FLOUR ON THE CHEMICAL AND RHEOLOGICAL PROPERTIES OF WHEAT FLOUR DOUGH

E. A. El-Naggar, A. A. Abd El-Hamied, A. G. Nassar and E. M. Hassan
Food Science and Technology Department, Al –Azhar Uni., Assiut, Egypt

Received: 30 November 2014 Accepted: 14 June 2015

ABSTRACT

This work was conducted to study the effect of partial replacement of wheat flour (72% extraction) by different levels (5%, 10%, 15% and 20%) of raw, soaked and germinated fenugreek (*Trigonella foenum graecum*) seed flour on the chemical and rheological characteristics of the dough blends by using Extensograph and Farinograph tests. The fenugreek seed flour was obtained from either Giza-30 fenugreek seeds or that purchased from the local market. The fenugreek seed flour used in this study were also evaluated for their amino acids content and compared to that of the wheat flour (72%). Proximate composition of partial replacement of wheat flour by different levels of FSF was determined. Results indicated that incorporation of FSF obviously increased ($P \geq 0.05$) protein (30.23), fat (6.73), fiber (10.81), ash (5.32) and indispensable amino acid contents (5.22%) with increasing FSF replacement levels. The mineral contents of treated fenugreek seed flours almost were higher than the control samples. Germination process of FSF caused a decrease of most minerals higher than the soaking process. The replacement of wheat flour with FSF caused a decrease ($P \geq 0.05$) in extensibility of the dough (120mm) as measured by the Extensograph and an increase ($P \geq 0.05$) in resistance to extension (320BU), proportional number (2.46) and dough energy tests (50cm^2). Farinograph results showed that all additions of FSF increased water absorption (60.40%), weakened the dough (160BU) development time (2 min) and mixing tolerance index (130 BU), and decreased the arrival time (1min) and dough stability. The effects on dough development time, water absorption, and mixing tolerance index were intensified with GF samples under 5 or 10 levels, but not with raw or soaked fenugreek flour samples under the same levels. Generally, the addition of germinated fenugreek flour to wheat flour under 5 or 10 levels had a less deleterious effect on the chemical and rheological properties of dough than that of raw and/or soaked fenugreek flour.

Key words: Fenugreek seed flour; Wheat flour; Chemical composition; Mixing tolerance index; Rheological characteristics.

INTRODUCTION:

In the recent years, plant proteins are becoming an important protein source, for use as both functional food ingredients and nutritional supplements (El-Nasri and El-Tinay, 2007). Plant proteins, to be effectively and successfully utilized in different food applications, should ideally possess several desirable characteristics, referred to the functional properties. Plant protein are used in food as functional ingredients to improve stability and texture as well as the nutritional quality of the product (Gamlath and Ravindran, 2008). The use of plant proteins is almost limited to the protein of soybean seed. Studies should now focus on a search for protein from other sources, such as fenugreek (Trigonella foencem graecum) which is widely grown in Mediterranean region. It has a high proportion of protein (approximately 20 – 30%) as well as amino acid, 4-hydroxyisoleucine which has high potential for insulin stimulating activity. The fatty acids composition of fenugreek seed ranges from 5% to 10%, which is predominantly linoleic, lionlenic, oleic, and palmitic acids. It has 45 – 65% total carbohydrates with 15% of galactomannan.

Along with these macronutrients, the fenugreek seed also contains flavonoids, coumarins, saponins and more calcium, phosphorous, iron, zinc, and manganese than the most legumes (Hooda and Jood, 2005; Mathur and Choudhry, 2009 and Shalaby et al., 2012). It was reported that the fenugreek seeds blended with wheat flour had been used for function food ingredients and nutritional supplements.

Rheology is the study of the flow and deformation of materials. Generally, to measure rheological behavior, controlled and well-defined deformation is applied to a material over a given time and the resulting force response is measured to give an indication of material parameters and prediction of the material's response to the complex flows and deformation conditions often found in practical processing situations which can be inaccessible to normal rheological measurement (Sharma and Chauhan, 2000; and Weegels et al., 1996). Some investigation regarding the galactomannan of fenugreek had been carried out by some researchers. The structure of galactomannan of fenugreek seeds has galactose and mannose residues in the ratios of 1:1 or in few cases of 1:2. Fenugreek, with high galactomannan content, swells in cold water. The most important property of galactomannan is the high water binding capacity and formation of very viscous solutions (Toufeili et al., 1999). Many rheological test have been used in an attempt to predict final product quality such as mixing behavior, dough stability, dough development time, dough extensibility and dough resistance to extension. This is based on the structural engineering analysis of materials (Pagani, 2006).

Roberts et al., (2012) studied the correlation between chemical structure and rheological properties of gluten. They concluded that, cysteine content, degree of amidation and content of hydrophobic side chain amino acids have significantly effects on rheological properties. Rheological quality tends to decrease with increasing contents of low molecular weight protein fractions. Therefore, this study was designed to evaluate the effects of replacement wheat flour by 5, 10 , 15, and 20% of soaked and germinated fenugreek seed flours (SF and GF, respectively), obtained from Giza 30 or fenugreek seeds of the local market, on the chemical characteristics of dough the relation between supplement and rheological properties of the dough were also, investigated .

MATERIALS AND METHODS:

Fenugreek seeds (Trigonella foenum graecum) of Giza-30 were obtained from Crops research institute, Agriculture research center, Giza, Egypt. Wheat flour (72% extraction) and other ingredients were obtained from the local market.

Preparation of fenugreek seed flour (FSF). Fenugreek seeds, were cleaned and freed of broken seeds, dust and other foreign material then divided into three parts: the first part was raw, the second part was soaked, while the third part was germinated as follow:

Soaking: fenugreek seeds were soaked in tap water for 12 hr/37°C. A seeds to water ratio of 1:5 (w/v) was used. After discarding the un-imbibed water, the soaked seeds were rinsed twice in distilled water and then dried at 55-60°C (Hooda and Jood, 2005).

Germination: the soaked seeds were germinated in sterile Petri dishes lined with wet filter papers for 48h at 37°C, with frequent watering. The sprouts were rinsed in distilled water and dried at 55-60°C (Shalaby et al., 2012). The dried samples of raw, soaked and germinated seeds, were ground to fine powder in electric grinder to particles passing through 20 mesh sieve and then stored in plastic containers for further use.

Preparation of blends: wheat flour was supplemented by 5, 10, 15 and/or 20% of raw, soaked and germinated FSF. The flour mixtures were individually blended and homogenized, packed in polyethelene bags, tightly closed and stored at room temperature until utilized.

Proximate composition: Proximate composition was estimated by employing standard methods of analysis (AOAC, 1995). Total lysine was estimated according to the method described by Hooda and Jood, (2005). Mean value of three determinations was reported.

Rheological properties: Farinograph characteristics (water absorption, arrival time, dough stability, dough tolerance index, dough weakening and dough development time were carried out according to the method of the AACC (2000). Extensograph characteristics (Extensibility mm, resistance to extension B.U, dough strength energy cm^2 and proportional number) were carried out according to the method of the AACC (2000).

Amino acids composition: It was determined using a Mikrotechna AAA881 automatic amino acid analyzer according to the method of Moore and Stein (1963). Tryptophan was chemically determined by the method of Miller (1967).

Total minerals: The samples were wet acid digested, using a nitric acid and perchloric acid, mixture (HNO_3: $HCLO_4$, 5:1 w/v). The total amounts of Ca, Fe and Zn in the digested samples were determined by atomic adsorption spectrophotometry (Hooda and Jood, 2005)

Statistical analysis: The experimental data were determined in triplicate for all samples and subjected to analysis of variance (ANOVA) for a completely randomized design using a statistical analysis system SAS (2000). The least significant difference (L.S.D) tests were used to determine the differences among means at the levels of 0.05.

RESULTS AND DISCUSSION

Chemical composition of wheat flour as well as raw, soaked and germinated fenugreek seed flour:

Results in Table (1) showed that moisture, protein, fat, fiber, ash and the total nitrogen free extract (TNFE) of: 1- wheat flour (72% extraction rate) were 13.86 , 11.98, 1.27, 0.25, 0.55 and 72.09%, respectively, 2- soaked fenugreek seed flour were 8.13, 29.93, 5.86, 10.47, 5.05 and 40.56% respectively, 3- germinated fenugreek seed flour (GF of Giza 30) were 8.92, 30.23, 5.61, 10.81, 5.32 and 39.11% respectively, 4- raw fenugreek seed flour (RF Giza 30) were 8.16 , 29.85, 5.91, 10.26, 4.62 and 41.2% respectively.

From these data it could be stated that, WF had the highest value of moisture content (13.86), followed by GF(8.92), then RF(8.16%). While, SF had the lowest content (8.13), the crude protein content was the highest in GF sample, but the lowest was in the sample of control. The percentage of protein was 11.98, 29.85, 29.93 and 30.23% for control, RF, SF, and GF, respectively. The crude fat content was the highest in RFof Giza 30(5.91%) or obtained from local market(6.85%), samples but the lowest in control sample. Both of the ash and crude fiber contents of different treated fenugreek seed flours FSF were almost higher than the control sample. On contrast , the

T.N.F extract of different treated FSF were almost lower than the control sample. The results also indicated that protein, ash, fiber and fat had obviously increased significantly ($P \geq 0.05$) compared with control. While, the T.N.F extract were obviously decreased significantly ($P \geq 0.05$) compared with control. generally, the same trend was observed by FSF obtained from the local market These results agreed well with those reported by Sayed et al., (2000).

Additionally, the mineral contents of different treated (FSF) were almost higher than the control sample. Soaking and germination processes of FSF had a slight effect ($P \geq 0.05$) on the percentage of mineral composition. Germination process of FSF caused a decrease ($P \geq 0.05$) in the most of minerals higher than the soaking process. These changes in components may be due to the consumption of respiration during germination (Sharma and Chauhan, 2000).

Generally, a significant differences between FSF (Giza 30) and FSF (obtained from local market) were noticed for crude fiber and fat. FSF (Giza 30) produced slightly greater crude fiber values than fenugreek obtained from local market, wherease, FSF (Giza 30) produced slightly lower fat values than did FSF obtained from local market. These results agreed with those reported by Billaudece and Adrian, 2001 ; Dhingra and Jood, 2001; and Ammar et al., 2009.

Rheological characteristics of wheat flour doughs supplemented with fenugreek seed flour:

The effect of supplementation with FSF on the rheological characteristics of doughs was examined by using farinograph and extensograph apparatus on the fermentation period (135min).

Farinograph Tests: The effect of replacing wheat flour by different levels of RF, SF and/or GF (Giza 30 and/or local market) at levels of 5 ; 10 ; 15 and 20% on Farinograph tests are presented in Table (2) and Figures of farinograph curves. The results indicated an increase of water absorption ($P \geq 0.05$) compared with control by increasing the levels of RF, SF and/or GF (Giza 30 or local market). Water absorption of WF started with 55% and reached to 60.4% after the addition of 20% of RF, SF and /or GF (Giza 30 or local market). Results indicated that no significance ($P \leq 0.05$) differences in water absorption at the different levels of SF either Giza 30 or that obtained from local market, but the replacing by RF and/or GF at 15 and 20% lead to increasing ($P \geq 0.05$) the water absorption. It was noticed that water absorption of the flour increased ($P \geq 0.05$) by increasing the ratio of FSF to WF as shown in Table (2) and figures of farinograph curves. The obtained results are in accordance with those of Jyothsna and Rao, (1997), and Kenny et al., (2000).

Table (1): Chemical composition of wheat flours supplemented by raw, soaked and germinated fenugreek seed flours (Giza 30 and local market)

Components (%)	Wheat flour	Giza 30				Local market			
		RF[1]	SF[2]	GF[3]	L.S.D5%	RF	SF	GF	L.S.D5%
Moisture	13.86	8.16	8.13	8.92	0.69	8.16	8.13	8.92	0.65
Protein	11.98	29.85	29.93	30.23	1.06	29.53	29.58	29.79	0.95
Ash	0.55	4.62	5.05	5.32	0.32	4.60	4.97	5.07	0.35
Crude fiber	0.25	10.26	10.47	10.81	0.38	9.82	9.71	9.45	0.40
Fat	1.27	5.91	5.86	5.61	0.12	6.85	6.70	6.73	0.15
N.F.E[4]	72.09	41.2	40.56	39.11	0.75	41.04	40.91	34.97	0.70
Minerals (mg/100g)									
Ca	55.8	120	110	100	30.2	110	100	94	33.1
Fe	7.14	35.2	32.7	30.4	9.43	33.5	30.3	28.85	8.5
Zn	3.70	3.83	3.64	3.50	1.04	3.80	3.55	3.40	0.85

Mean values of three determinations.
Means in the same row were calculated by different significance (P≤0.05) of all treatments
[1]RF: raw fenugreek seed flour
[2]SF: Soaked fenugreek seed flour
[3]GF: Germinated fenugreek seed flour
[4]N.F.E.: The nitrogen free extract was calculated by difference

Development time is the time from the first addition of water to the time the dough reaches the point of greatest torque. During this phase of mixing, the water hydrates the flour components and the dough is developed. Results declared that replacing WF by different levels of RF, SF and GF had no significant (P ≤ 0.05) changes were realized compared with control (1.5 min). Dough mixing studies showed that inclusion of RF, SF and GF blends delayed farinograph arrival time and decrease dough stability when substituted for wheat flour. Also, results indicated that, no significant (P≤ 0.05) changes in the stability time under 5 and 10replacement levels of SF and / or GF. While, replacing FSF by 15 or 20% lead to decrease (P≥ 0.05) the stability time, which started with 3 min of the control to 1.5 min at levels of 15 and 20% for RF, SF and/or GF either Giza 30 or local market. Similar results were obtained by Manohar and Rao, (1997).

According to the weakening of the dough resulted given in Table (2) and fingers .of farinograph curves, declared that, addition of FSF at different levels resulted in an increase (P≥ 0.05) in the dough weakening. Moreover, the highest increase (P≥ 0.05) were observed under 15 and 20% levels for RF (Giza 30) which reached to 140 and 160 B.U., respectively, while it was 100 B.U. for the control. But, results indicated that no significant (P≤ 0.05) difference were recorded in dough weakening under 5 and 10 levels for SF and GF either Giza 30 or obtained from local market. Therefore, the increment in the dough weakening may be explained by the small amount of gluten in the blend. These results were in agreement with those obtained by Manohar and Haridas, (2002).

With respect to the tolerance index, it was noticed that, the addition of FSF obviously caused increasing significant ($P \geq 0.05$) differences compared with control (Table 2). These findings could be related to the breakdown of gluten network and its small amount. These findings were similar with those obtained by Muhammad et al., (2010).

Incorporation of FSF with different treatments(5 , 10 , and 20% levels) showed a significant ($P \geq 0.05$) differences on water absorption, arrival time, dough development time , dough stability, tolerance index and dough weakening as measured by farinograph. Dough mixing studies showed that inclusion of FSF blends delayed farinograph arrival time and decreased dough stability when substituted for wheat flour. As the level of FSF and Kind of treatment in composite dough's increased, farinograph absorption and mixing tolerance index, but mixing time (dough development time) and dough stability decreased as substituted level increased from 15 to 20%.

Generally, a significant ($P \leq 0.05$) differences between FSF (Giza 30) and FSF (local market) were observed for dough development time, dough stability and dough weakening. FSF (Giza 30) Produced slightly greater dough development time , dough stability and dough weakening values than did FSF (obtained from the local market).

Extensograph tests: The effect of replacing wheat flour (72% extraction) by different levels of RF, SF or GF either Giza 30 or local market on the extensograph tests are represented in Table (3) and figures of extensograph curves.

The results indicated an increase ($P \geq 0.05$) in the resistance to extension which recorded 260, 280, 283, and 285 B.U with 5 , 10 , 15 , and 20% addition of RF (Giza 30), respectively as compared with control samples (160 B.U). On the other hand, no significant ($P \leq 0.05$) differences were observed between the resistance to extension at level of 5% and 10% for SF and GF either Giza 30 or local market.

Regarding to extensibility results, a fluctuant reduction in extensibility was observed upon increasing the levels of RF, SF and GF either Giza 30 or that obtained from local market. The dough extensibility started with 140 mm. in control sample, then reduced to 120 mm in case of 5 and 10% levels of RF (Giza 30). These findings may be attributed to the deficiency of gliadine in fenugreek protein.

Concerning the dough energy, the results indicated an increase ($P \geq 0.05$) in dough energy with increasing the levels of RF, SF and GF either Giza 30 or local market, which may be attributed to the high resistance to extension..

Table (2): Farinograph parameters of wheat flour supplemented by raw, soaked and germinated fenugreek seed flour levels (Giza 30 and local market)

Farinograph data		Water absorption (%)		Arrival time (min)		Dough development time (min)		Dough stability (min)		Tolerance index (Bu)		Weakening (Bu)	
Control		56		1.30		1.50		3.00		50		100	
		A	B	A	B	A	B	A	B	A	B	A	B
WF: RF	5	57	56.40	1.00	1.00	1.50	1.50	2.50	2.00	80	60	110	110
	10	58	57.00	1.00	1.00	1.50	1.50	2.00	2.50	85	60	120	110
	15	58.80	58.00	1.15	1.10	1.5	1.50	1.50	1.50	100	80	140	120
	20	59.60	59.30	1.20	1.20	2.00	1.00	1.50	1.50	130	100	160	150
WF: SF	5	54.80	54.40	1.00	1.00	1.50	1.50	2.00	2.00	70	55	115	110
	10	57.50	55.00	1.00	1.00	1.50	1.50	2.00	1.50	75	60	120	120
	15	55.00	55.30	1.00	1.00	1.50	1.00	1.50	1.50	80	70	140	120
	20	56.00	56.00	1.00	1.00	200	1.50	1.50	1.50	85	75	140	130
WF: GF	5	56.80	56.20	1.00	1.00	1.00	1.50	2.00	2.00	65	50	110	110
	10	57.50	57.00	1.00	1.00	1.50	2.00	2.00	2.00	75	55	120	105
	15	59.30	58.10	1.10	1.10	2.00	1.50	2.00	1.50	80	60	125	120
	20	60.40	59.50	1.15	1.10	2.00	1.50	1.50	1.50	80	70	130	120
L.s.d 5%		3.05	2.95	0.178	0. 193	1.10	0.94	1.24	1.21	11.98	9.77	20.51	18.95

Mean values of three determinations.

Means in the same column were calculated by different significantly ($P \leq 0.05$) .

A: Giza 30; B: local market.

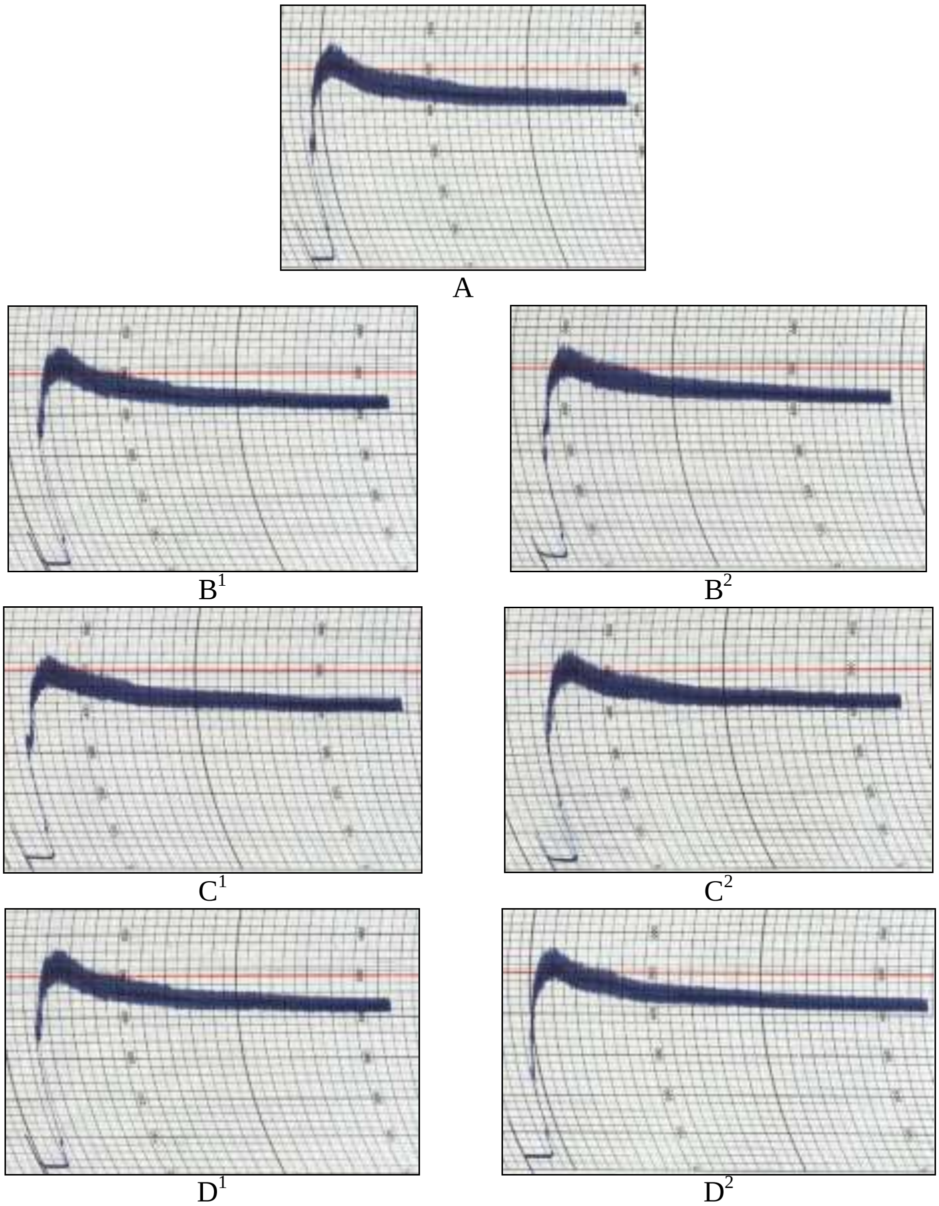

Fig. (1): Farinograph curves of wheat flour (72%) dough supplemented with 5% raw, soaked or germinated fenugreek seeds flour of Giza 30 (B^1, C^1 & D^1, respectively) and with 5% raw, soaked or germinated fenugreek flour of local market seeds (B^2, C^2 & D^2, respectively). (a) Control, 100% Wheat flour (72%) .

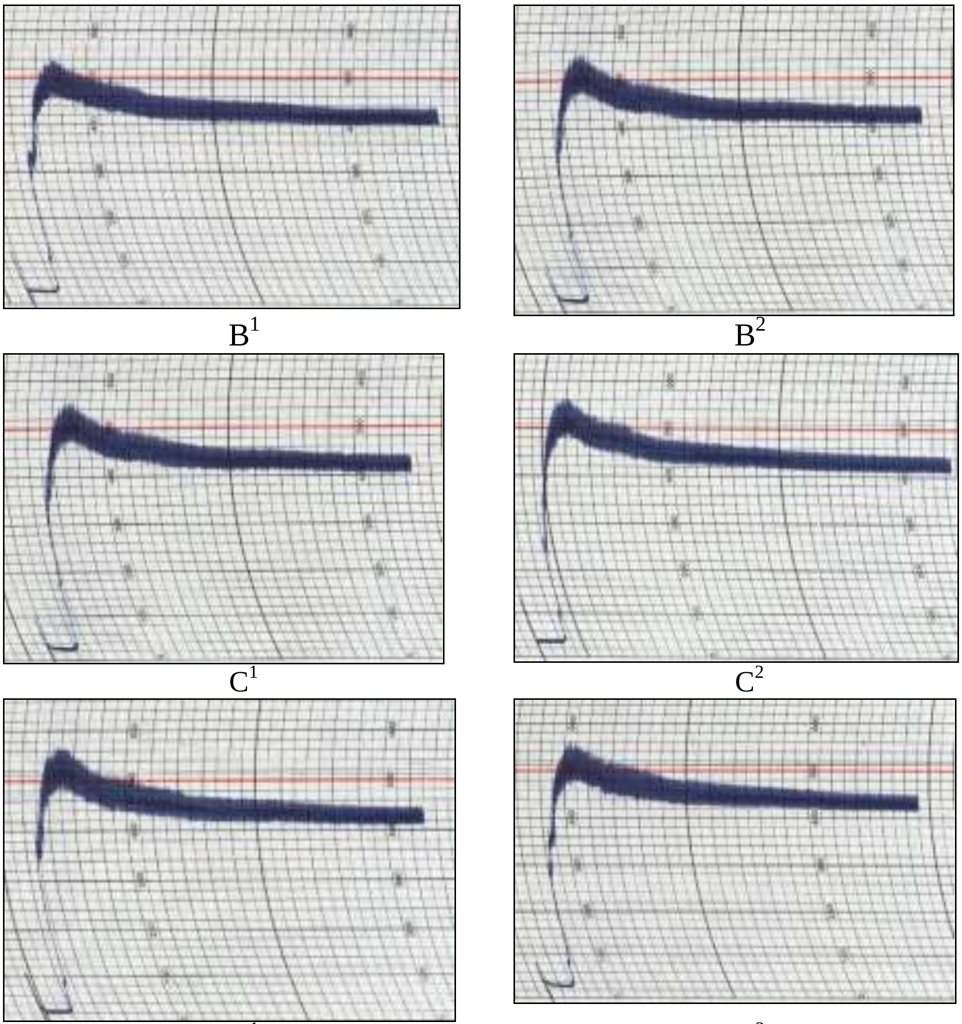

Fig. (2): Farinograph curves of wheat flour (72%) dough supplemented with 10% raw, soaked or germinated fenugreek seeds flour of Giza 30 (B1, C1 & D1, respectively) and with 5% raw, soaked or germinated fenugreek flour of local market seeds (B2, C2 & D2, respectively). .

With respect to the addition of different levels of treated FSF for Giza 30 or that obtained from local market, an increase ($P \geq 0.05$) in the proportional number was observed, which could be related to the increase of resistance to extension and the reduction in extensibility. These findings were similar with those abstained by Toufeili et al., 1999; Weegels et al., 1996; Kenny, 2000; Manohar and Haridas, 2002; and Ammar et al., 2009.

Amino acids content of wheat flours supplemented by RF, SF and GF:

The effect of replacing wheat flour by different treated FSF under the best levels of 5 and 10% on the amino acids content of the produced mixtures were discussed as follow: The effect of supplementation of wheat flour with FSF on the essential amino acids were presented in Table (4). Results initially indicated obviously an increase ($P\geq 0.05$) in total indispensable amino acids (IAAs), compared with control. Data indicated exceeding rate in total I.A.A.s by 1.33 and 1.57, respectively at 5 and 10% of RF supplementation level of (Giza 30), whereas the increase ($P\geq0.05$) in total I.A.As by 1.35 and 1.44, respectively at 5 and 10% RF supplementation level of obtained from the local market. Beside the replacement by 5 or 10% with soaking or germination processes for FSF either Giza 30 or local market lead to high increase ($P\geq0.05$) by 1.52 (5% SF, Giza 30), 1.43 (5% SF, local market), 1.67 (10% SF, Giza 30), 1.64 (10% SF, local market), 1.52 (5% GF, Giza 30), 1.58 (5% GF, Local market), 1.77 (10% GF, Giza 30), and 1.78 (10% GF, Local market) in comparison with wheat flour.

The above mentioned results indicated an increase in all essential amino acids under the supplementation with 5 and/or 10% FSF. Also, data indicated obviously an increase ($P\geq0.05$) in total dispensable amino acids (DAAs) content compared with control. Findings indicated exceeding rate in DAAs content by 1.94 and 3.12 respectively at 5 and 10% of RF supplementation level, (Giza 30), whereas, the increase in total DAAs by 1.47 and 2.78 respectively at 5 and 10% of RF supplementation level, (local market). Beside the replacement by 5 or 10% with soaking or germination process for FSF either Giza 30 or local market lead to the high significant ($P\geq0.05$) increase.

The giving results declared that, addition of 5 and 10% of different treated FSF lead to improve the rheological behaviors of wheat flour dough, and increase the percentage of all essential and non-essential amino acids content in the produced mixtures in comparison with the wheat flour (control). These findings were similar with results obtained by Dhingra and Jood, 2001; Hooda and Jood, 2005; Wa, 2009; and Masood and Batool, 2010.

Table (3): Extensograph parameters of wheat flour supplemented by raw, soaked and germinated fenugreek seed flour levels (Giza 30 and local market).

Extensograph Data		Dough extensibility (E) mm		Dough resistance to extension (R) BU		Proportional number R/E		Dough energy $(cm)^2$	
Control		140		160		1.14		30	
		A	B	A	B	A	B	A	B
WF: RF	5	120	125	260	270	2.16	2.16	33	34
	10	120	130	280	270	2.33	2.07	36	36
	15	130	130	283	310	2.17	2.38	40	44
	20	125	130	285	320	2.28	2.46	45	50
WF: SF	5	130	130	175	180	1.34	1.38	32	35
	10	130	130	190	195	1.46	1.50	37	36
	15	130	135	210	220	1.61	1.62	38	39
	20	125	140	220	220	1.76	1.57	40	40
WF: GF	5	130	135	180	190	1.38	1.40	35	35
	10	134	140	190	210	1.41	1.5	37	39
	15	140	145	200	200	1.42	1.37	40	40
	20	140	145	210	220	1.50	1.51	41	43
L.s.d 5%		11.59	12.30	60.28	55.95	0.597	0.501	4.022	3.69

Mean values of three determinations.

Means in the same column were calculated by different significantly ($P \leq 0.05$)

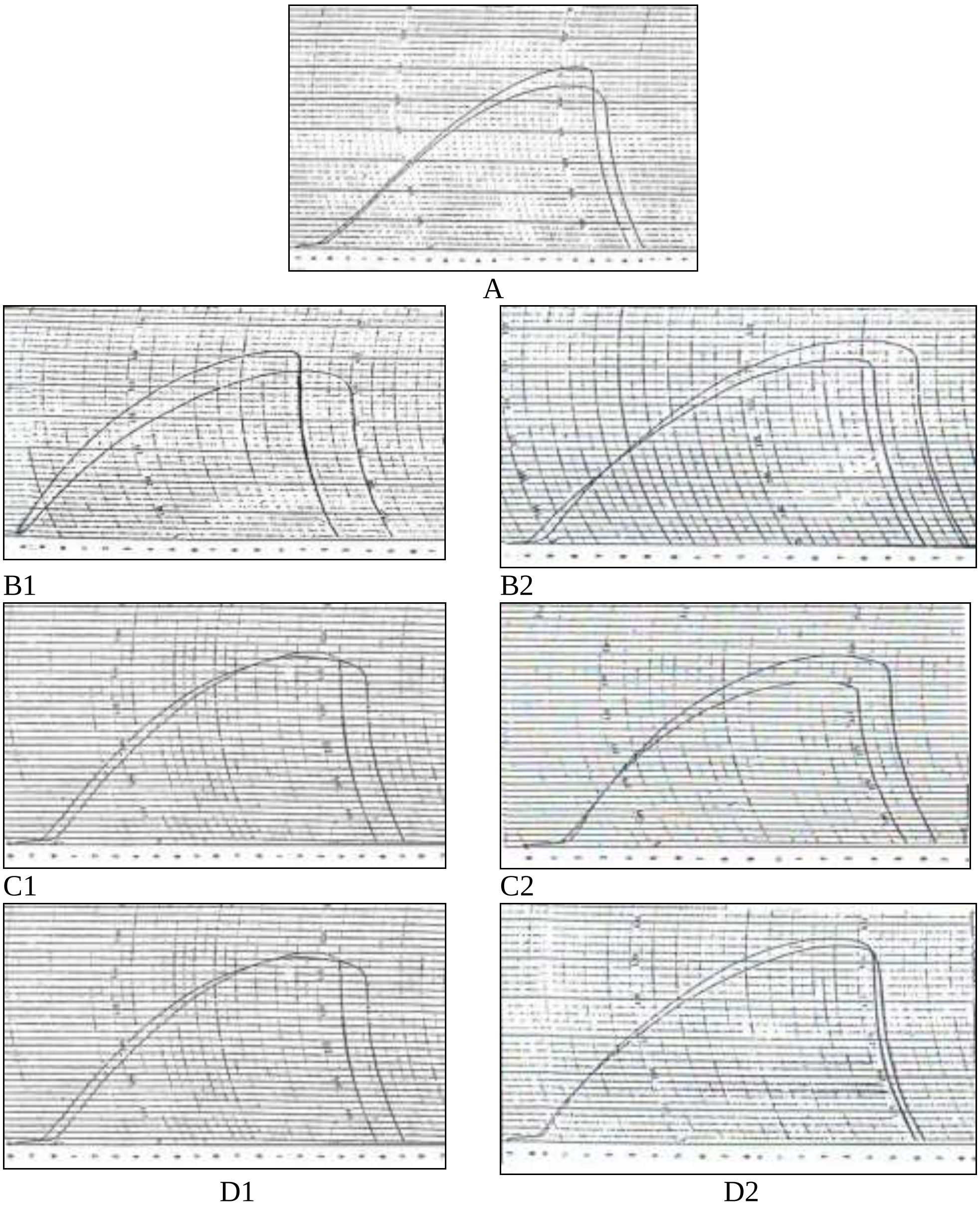

Fig. (3): Extensograph curves of wheat flour (72%) dough supplemented with 5% raw, soaked or germinated fenugreek seeds flour of Giza 30 (B1, C1 & D1, respectively) and with 5% raw, soaked or germinated fenugreek flour of local market seeds (B2, C2 & D2, respectively). (a) Control, 100% Wheat flour (72%) .

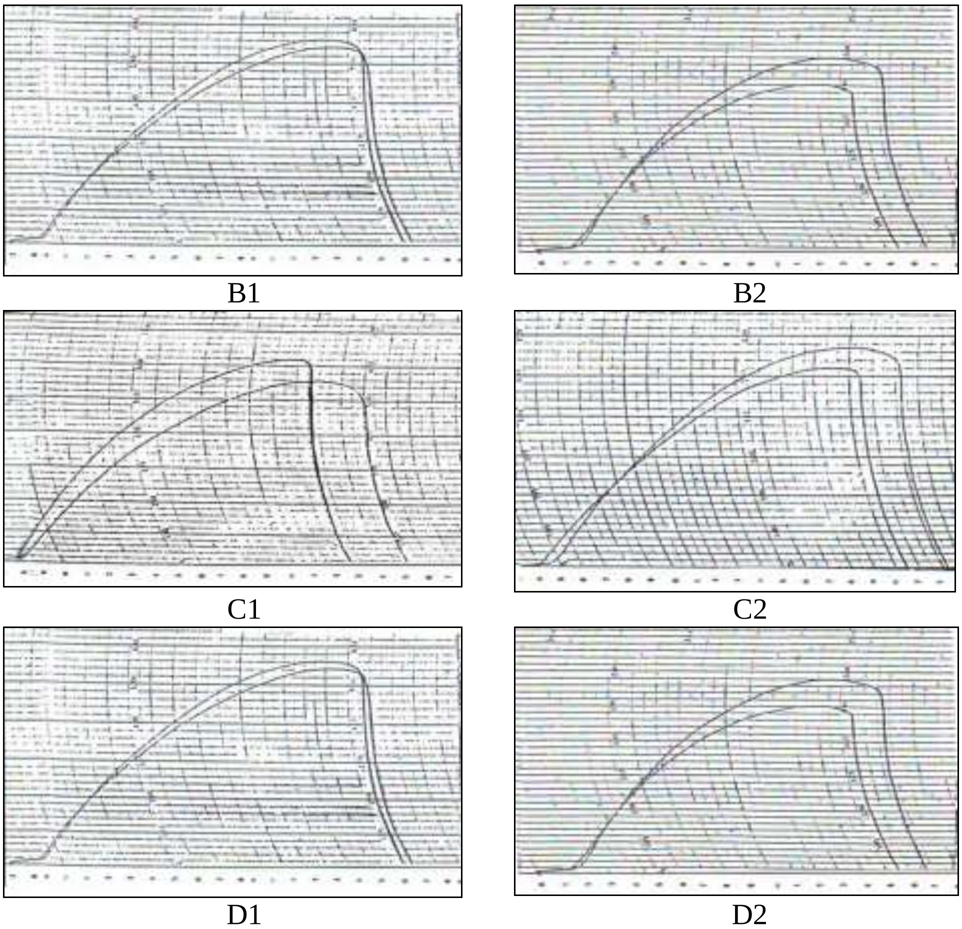

Fig. (4): Extensograph curves of wheat flour (72%) dough supplemented with 5% raw, soaked or germinated fenugreek seeds flour of Giza 30 (B1, C1 & D1, respectively) and with 5% raw, soaked or germinated fenugreek flour of local market seeds (B2, C2 & D2, respectively).

CONCLUSION:

It may be inferred from the present study that FSF either Giza30 or obtained from the local market could be incorporated up to 10%replacement level of germinated or soaked FSF into wheat flour dough to play an important role in their chemical and rheological quality properties. Consequently, used as partial supplementation. Furthermore, development and utilization of germinated or soaked FSF will not only improve the chemical and rheological properties of the general population but also helps those suffering from degenerative disease.

Table (4) Amino acids composition of wheat flours supplemented by raw, soaked and germinated fenugreek seed flours (Giza 30 and local market) (gm/100gm flour)

Treatments Amino acids	Control 72%	RF				SF				GF				L.S.D 5%
		5%		10%		5%		10%		5%		10%		
		A	B	A	B	A	B	A	B	A	B	A	B	
Leucine	0.678	1.02	0.93	1.11	1.05	1.093	1.05	1.16	1.125	1.10	1.09	1.18	1.20	
Isoleucine	0.299	0.354	0.385	0.464	0.45	0.44	0.43	0.52	0.51	0.46	0.48	0.53	0.53	0.107
Lysine	0.251	0.601	0.48	0.611	0.55	0.59	0.57	0.67	0.66	0.69	0.65	0.78	0.78	
Meth+cystin	0.196	0.20	0.199	0.25	0.22	0.24	0.21	0.28	0.27	0.25	0.23	0.31	0.31	
Phenylalanine	0.581	0.66	0.65	0.741	0.694	0.72	0.69	0.784	0.77	0.65	0.73	0.79	0.80	
Tyrosine	0.200	0.215	0.22	0.274	0.23	0.26	0.25	0.29	0.29	0.27	0.30	0.31	0.31	
Therionine	0.244	0.235	0.35	0.47	0.42	0.44	0.41	0.48	0.47	0.40	0.45	0.49	0.49	
Treptophan	0.122	0.172	0.163	0.18	0.165	0.175	0.162	0.18	0.17	0.16	0.18	0.20	0.20	
Valine	0.345	0.417	0.464	0.498	0.42	0.485	0.43	0.54	0.53	0.47	0.51	0.59	0.60	
Total IAA	2.92	3.874	3.841	4.59	4.199	4.44	4.20	4.904	4.79	4.45	4.60	5.18	5.22	
Aspartic	0.498	0.95	0.92	1.03	0.90	1.02	0.99	1.06	1.04	1.03	1.05	1.12	1.14	
Serine	0.589	0.495	0.56	0.713	0.65	0.69	0.57	0.71	0.69	0.63	0.64	0.72	0.73	
Glutamic	4.085	4.32	4.21	4.41	4.25	4.32	4.20	4.33	4.28	4.30	4.45	4.44	4.51	
Proline	0.735	0.85	0.83	0.93	0.87	0.92	0.85	0.99	0.97	0.93	0.95	1.02	1.04	
Glycine	0.231	0.26	0.23	0.33	0.29	0.32	0.30	.36	0.32	0.33	0.33	0.42	0.40	
Alanine	0.370	0.480	0.40	0.497	0.49	0.48	0.45	0.54	0.53	0.50	0.52	0.58	0.58	
Histidine	0.253	0.24	0.25	0.33	0.30	0.32	0.28	0.37	0.32	0.39	0.35	0.432	0.42	
Arginine	0.996	1.34	1.25	1.40	1.35	1.37	1.30	1.42	1.39	0.98	1.35	1.09	1.41	
Total DAA	7.76	8.93	8.65	9.64	9.10	9.44	8.94	9.78	9.54	9.09	9.64	9.82	10.23	
TAA	10.68	12.804	12.491	14.23	13.29	13.88	13.14	14.68	14.33	13.54	14.26	15	15.45	

Mean values of three determinations.

Means in the same row were calculated by different significantly ($P \leq 0.05$) of all treatments

References

AACC (2000). American Association of Cereal Chem. Approved Methods of the AACC . The Association St. Paul, Minn., U.S.A.

Ammar, M. S.; Hegazy, A. E. and Bedeir, S. H. (2009). Using of taro flour as partial substitute of wheat flour in bread making . World .J. of Dairy and Food Sci., 2: 94 – 99 .

AOAC (1995). Official Methods of Analysis, 16th ed. Association of Official Analytical Chemists Internation, Arlington, Virginia, U.S.A.

Billaudece, M. and Adrian, J. (2001). Fenugreek composition, nutritional value and physiological properties. J. Sci. Aliments., 1: 326-332.

Dhingra, S. and Jood, S. (2001). Organoleptic and nutritional evaluation of wheat breads supplemented with soy bean and barley flour. Food Chem., 77: 479-488.

El- Nasri, A. and El-Tinay, A. H. (2007). Functional properties of fenugreek (Trigonella foenum grecum) protein concentrate . Food Sci and Techn., 3: 582–589.

Gamlath, S. and Ravindran,G. (2008). Extruded products with fenugreek chickpea and rice: physical properties. Sensory acceptability and glycaemic index. J. of Food Eng., 90: 44-52.

Hooda, S. and Jood, S. (2005). Organoleptic and nutritional evaluation of wheat biscuits supplemented with untreated and treated fenugreek flour. Food Chem., 90: 427- 435.

Jyothsna, S .R. and Rao, P. H. (1997). Effect of incorporation of sorghum flour to wheat flour on chemical, rheological and bread character is tics . J . Food. Sci. Techn., 3: 251-254.

Kenny, p.; Wehrle, K. and Stanton, C. (2000). Incorporation of dairy ingredients into wheat bread: effects on dough rheology and bread quality . European Food Res and Techn., 210: 391 – 396.

Manohar, R. S. and Haridas, R. P. (2002). Interrelationship between rheological characteristics of dough and quality of biscuit; use of elastic recovery of dough to predict biscuit quality. Food Res Inter., 35: 807 – 813.

Manohar, R.S. and Rao, P.H. (1997). Effect of mixing period and additives on the rheological characteristics of dough and quality of biscuit. J. of Cereal Sci., 25: 197. 206.

Masood, S. B. and Batool, R. (2010). Nutritional and functional properties of some promising legumes protein isolates. Pakistan. J. of Nutr., 9: 373-379.

Mathur, P. and Choudhry, M. (2009). Effect of domestic processing on proximate composition of fenugreek seeds. J. of Food Sci and Techn., 3: 255-258.

Miller, E. L. (1967). Determination of tryptophan content in feeding stuffs with particular reference to cereal . J. Sci. Food. Agric., 18: 381- 386.

Moore, S. and Stein , W.H. (1963). Chromatographic deretmination of amino acids by the use of automatic recording equipment. In methods of Enzymology. New York;, P. 860 – 864.

Muhammad, A.; Muhammad, N. S.; Amer, M.; Khalid, N.; Saeeda, R. and Samina, K. (2010). Comparison of different wheat varieties grown in Punjab for leavened flat bread (Naan)production . Pakistan . J. of Nutr., 2 : 148 – 150 .

Pagani, A. (2006). Development of a baking procedure for the production of oat- supplemented wheat bread. Inter. J. of Food Sci and Techn., 41: 151- 157.

Roberts, K. T.; Cui, S.W.; Chang, Y. H.; Ng, P. K. W. and Graham, T. (2012). The influence of fenugreek gum and extrusion modified fenugreek gum on bread, Food Hydro., 26: 350 – 358.

SAS (2000) SAS Users Guide Statistical Analysis System SAS Institute Inc.cary NC

Sayed, A.; Tollba, K.H. and Habashy, H.N. (2000). Technological chemical and biological studies on fenugreek seeds (Trigonalla foenum graecum L.) Arab. Unvi. J. Agric. Sci. Ain Shams Univ., Cairo., 1: 223-234.

Shalaby, M. T.; Abou Raya, M. A.; Ahmed, A. E. and Abd El- All, W. M. M.(2012). Chemical Studies for Fenugreek Seeds and Some Treatments. Arab. Mans. Con. Food Tech., Agric. Res. Center, Giza, Egypt., 3:220-228.

Sharma, H. R. and Chauhan, G.S. (2000). Physicochemical and rheological quality characteristics of fenugreek-supplemented wheat flour. J. Food Sci and Techn., 37: 87-90.

Toufeili, B.; Ismail, L.; Shadarevion, B.; Raalbaki, B. S.; Katkar, A. E.; Bell, M. and Schofield, J. D. (1999). The role of gluten protein in the baking of Arabic bread. J. of . Cereal. Sci, 30: 255-265.

Wa. G. (2009). Amino acides: metabolism, functions, and nutrition. Amino Acids., 37: 12 – 17.

Weegels, P. L.; Hamer, R. J. and Scofield, J. D. (1996). Functional properties of wheat glutenin. J. of Cereal Sci., 23: 118 – 129.

تأثير دقيق بذور الحلبة على الخواص الكيميائية و الريولوجية لعجينة دقيق القمح

عيد السيد عبدالعزيز النجار؛ عادل احمد عبد الحميد؛ احمد جمعة نصار؛ عيسي محمد حسن
قسم علوم وتكنولوجيا الاغذية – كلية الزراعة – جامعة الازهر –اسيوط – مصر

تم دراسة تأثير الاستبدال الجزئي لدقيق القمح (استخلاص 72%) بمستويات مختلفة بنسب (5%، 10% ، 15%، 20%) من دقيق الحلبة جيزة 30 ودقيق الحلبة المشترى من السوق المحلى (الخام أو المنقوع أو المنبت) على الخواص الكيميائية والريولوجية لخلطات العجين الناتج بواسطة جهازي الأكستنسوجراف والفارينوجراف مع مقارنته بالعجين الناتج من دقيق القمح استخلاص 72%. وقد دلت نتائج دراسة الاستبدال الجزئي للتركيب الكيميائي لخلطات العجين زيادة المحتوى من البروتين (30,23%) والدهن (6,73%) والألياف (10,81%) والرماد(5,32%) والليسين (0,78%) كما تبين زيادة المعادن لدقيق الحلبة المعامل مقارنة بالعينات القياسية، وأن معاملة الإنبات لدقيق الحلبة سبب نقصاً في معظم المعادن المختبرة مقارنة بمعاملة النقع. وأظهرت النتائج المتحصل عليها من جهاز الفارينوجراف زيادة نسبة امتصاص الماء (60,40%) وضعف العجين (160وحدة برابندر) ومدة الخلط (2 دقيقة)، كما لوحظ نقص فى الوقت اللازم لنضج العجين(واحد دقيقة)، ومعامل تحمل الخلط (130 وحدة برابندر) وفترة الثبات (واحد دقيقة) بزيادة مستوى الاستبدال بدقيق الحلبة، وأن كلاً من مدة الخلط ونسبة امتصاص الماء ومعامل تحمل الخلط كانت الأفضل فى عينات الدقيق المستبدل بدقيق الحلبة المنبت تحت مستوى 5 أو 10% من عينات الدقيق المستبدل بدقيق الحلبة الخام أو المنقوع تحت نفس المستوى. وقد أظهرت نتائج الدراسة باستخدام جهاز الأكستنسوجراف أن إضافة دقيق الحلبة إلى دقيق القمح ينتج عنه نقص فى مطاطية العجين. وأن استخدام دقيق الحلبة الخام له تأثير ريولوجى اقل من استخدام دقيق الحلبة المعامل سواءً بمعاملة النقع أو الإنبات. وأظهرت نتائج الدراسة زيادة مترددة في قيم كل من المرونة والرقم النسبي وقوة العجين بزيادة مستوى الاستبدال بدقيق الحلبة في جميع المعاملات مقارنة بالعينة القياسية. حيث أمكن تحسين الخواص الكيمائية و الريولوجية للعجين باستخدامك دقيق الحلبة المعامل بالنقع أو الإنبات .